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ABSTRACT

These four reports provide details of projects to design and implement courses to be offered as requirements for the associate degree program in composites and reinforced plastics technology. The reports describe project activities that led to development of curricula for four courses: composite materials, composite materials fabrication I, composite materials fabrication II, and composite materials testing. These types of activities are discussed: analysis of the existing program; contacts with individuals and businesses in the field; literature review; consultations with professional organizations; visits to businesses; attendance at seminars; and student recruitment. Attachments to each report include minutes of the Composites Advisory Committee meeting; the Delaware County Community College Composites and Reinforced Plastics Technology curriculum; and the following course materials: course objectives and course outline; course syllabus; a list of all equipment acquired for the course; a bibliography that includes books, periodicals, videos, slides, and software acquired by the project; a list of professional societies of which the college is a member; and an announcement of a symposium offered by the project. (YLB)

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ED329741

FINAL REPORT

INDUSTRY TO EDUCATION TECHNICAL TRANSFER PROGRAM & COMPOSITE MATERIALS

COMPOSITE MATERIALS COURSE
FABRICATION I COURSE
FABRICATION II COURSE
COMPOSITE MATERIALS TESTING COURSE

RACHEL MASSUDA

DELAWARE COUNTY COMMUNITY COLLEGE

MEDIA, PENNSYLVANIA 19063

SEPTEMBER 30, 1989

PENNSYLVANIA DEPARTMENT OF EDUCATION

BUREAU OF VOCATIONAL AND ADULT EDUCATION

CURRICULUM AND PERSONNEL DEVELOPMENT SECTION

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ACKNOWLEDGMENT

We would like to thank members of our Advisory Committee for all the helpful advice and comments in planning the curriculum.

We would like to express our appreciation to the administrators, faculty and staff at the Marple Technical School.

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Project Abstract

This final report is submitted by Delaware County Community College, Media, Pennsylvania, in compliance with the state requirements for the completion of project # 85-9018 'Industry to Education Technical Transfer Program - Composite Materials: Composite Materials Course,' funded for fiscal year 1988-1989.

The purpose of this document is to report on the progress made in the design, and implementation of a course in 'Composite Materials' to be offered as one of the requirements for the associate degree program in composites and reinforced plastics technology.

The objectives of the project were to complete course materials and obtain approval by the College's Curriculum Review Committee, Vice President of Instruction, and Board of Trustees.

The objectives achieved were the completion and approval of course outline and objectives for inclusion in the college catalogue for 1989-1991.

contract #85-9018
Delaware County Community College

FINANCIAL SUMMARY

1899-1989 COMPOSITES TECHNOLOGY CURRICULUM DEVELOPMENT
COMPOSITE MATERIALS COURSE

	APPROVED AMOUNT	ACTUAL EXPENDITURE
Non-instructional Salaries and Benefits:		
Project Administrator - Edwin Glasberg 5% of full-time salary	$ 1,650	
Benefits @ 26%	429	
Instructional Specialist - Edwin Fink 16.6% of full-time salary	5,833	
Benefits @ 26%	1,517	
Instructional Specialist - Rachel Massuda 16.6% of full-time salary	5,833	
Benefits @ 26%	1,517	
Clerical Staffperson - Joan Hickman 80 hrs. x $10/hr.	800	
Benefits @ 37.5%	300	
subtotal	$ 17,879	$ 17,381.10
Other:		
Honoraria for consultants	200	0
Travel - 1,778 miles @ .225/mile	400	330.61
Program materials/supplies/ communications - paper, etc.	500	592.91
subtotal	$ 1,100	$ 922.81
indirect @ 8%	1,518	1,464.31
TOTAL	$ 20,497	$ 19,768.22

Project Approach

This project is a continuation of contract number 85-8020 and 86-8006 funded for the fiscal year 1987-1988. The individuals involved in the project are Dr. Rachel Massuda and Mr. Edwin Fink under the supervision of Dr. Edwin Glasberg, Assistant Dean for Technology.

Following training by the faculty members at the Boeing Helicopter Company, and the drafting of the preliminary requirements for the associate degree program, extensive work was done to analyze and improve on the program, define all requirements, revise course outline and objectives, rewrite the syllabus for the course and structure preliminary lesson plans.

Other activities of the group included contacts with individuals and businesses involved in composites, recruiting, equipment selection, reviewing books and articles, attendance at meetings, short courses and seminars. To improve on the practical aspects of the curriculum, consultations were made with curriculum or education committees of the Society of Manufacturing Engineers; Society for the Advancement of Materials and Process Engineering; Society of Plastics Engineers; and area college and university faculties and administrators.

Visits were made to the following companies and organizations; Boeing Helicopter, Clifton Plastics, Silverton Yacht, Fiber Metal, DuPont, Arco, Spatz Fiberglass, Edon Corporation, GITCO, Naval Air Development Research Center, The Williamson School, Llyod Instrument, Tinus Olson, and Krautkramer Branson Company.

The following seminars were attended:

- COGSME Fabricating Composites Conference & Exposition 9/13/88 - 9/15/88
- SAMPE, Wilmington, Philadelphia ' Introduction to Composites' Tutorial and Exposition 3/9/89
- NAIT Seminar 3/10/89
- SME 'Simplification of Resin Transfer Molding Workshop 3/30/89
- Solid Waste Management Conference 3/31/89
- Penn State's 'Advanced Filamentary Reinforced Polymer Composites Workshop' 5/2/89
- Plastic Recycling Applications Seminar 5/22 & 5/23/89
- Several of the monthly meetings of SAMPE

The scope of the Advisory Committee was expanded by inviting two additional members to join: Dr. MaryGail Hutchins of LNP division of ICI Americas and Mr. George Colbert, Chairman of the Education Committee of the Society of Plastics Engineers. A meeting was held on March 29, 1989. Attachment 1 gives the minutes of the meeting.

A special effort was made to recruit students. Contact was initiated and information mailed to all county high schools. A presentation was made to the guidance counselors during a meeting at the Delaware County Intermediate Unit. Seven area high schools were visited for specific meetings with guidance counselors and presentations to interested students. An open house was held for technical school students to visit the laboratory and see the equipment. Another was held for DCCC students and staff. Participation in the Technology Career Day

at the college for high school students and the public with an appearance from representatives of Dupont, Boeing Helicopter and Bently-Harris companies was successful. A table top exhibit was held at the local Society of Plastics Engineers Vendors' night.

A list of 55 companies in Southeastern Pennsylvania, New Jersey and Delaware was assembled. Telephone interviews were made with representatives of those companies to determine the job outlook in this discipline.

Project Summary

The curriculum development phase for this course is complete. A copy of the curriculum, course outline and objectives are included in Attachment 2. The revised curriculum was approved by the DCCC's Curriculum Review Committee, the Vice President for Instruction, and the Board of Trustees for inclusion in the 1989 - 1991 college catalogue. The course syllabus shown in Attachment 3 was completed, including implementation of the recommendations of the Advisory Committee. An instructional schedule has been developed. Lesson plans for the course have been assembled, and textbooks have been chosen.

Recommendations for equipment were made and purchase orders placed by purchasing department. The equipment on hand was tested and operated. A list of all the equipment acquired is given in Attachment 4.

A mailing list of 40 prospective students was compiled.

Results of the employment opportunity survey show that there is a growing shortage of trained employees and the prospect for employment for graduates of the program seems excellent.

An extensive bibliography of books, periodicals, videos, and slides has been acquired. Some have been evaluated for use as textbooks. A list of the bibliography is given in Attachment 5. All activities were augmented to keep current in the latest technical developments by membership in the professional societies listed in Attachment 6.

A one day symposium attended by students, faculty and the general public was held on the Applications of Plastics and Composites to Architecture and Construction. A copy of the announcement is given in Attachment 7.

MINUTES OF THE COMPOSITES ADVISORY COMMITTEE MEETING
March 29, 1989

PRESENT: Mr. George Carlson, Mr. Edwin Fink, Dr. Edwin Glasberg, Dr. Roy Henrichsen, Dr. MaryGail Hutchins, Dr. Rachel Massuda, Dr. Paul McQuay and Mr. Andrew Peoples.

1. Dinner was served at 5:45 p.m.

2. A verbal progress report indicated that our new catalogs had just been returned from the printer and copies of the catalogs were distributed. It was pointed out that our curriculum development work was nearly completed and we were now paying specific attention to developing seminars. One such seminar relating to composites in the construction area has already been held. It was further mentioned that our laboratory is nearing completion and that by the summer we should be ready to begin instructional programs. It was noted that a Career Day program was held during the month of March and the success of that program was indicated by 17 high school students and 13 adults leaving their names and addresses as being interested in participating in composites technology. Dr. Massuda pointed out that she had been involved in visitation to the high schools.

3. Dr. Glasberg indicated to the group the locations of the program and courses as they appear in the catalog. We further pointed to the fact that these classes are currently open for registration.

4. An effort was made to elicit from the committee suggestions for a seminar topic for the coming year. The committee indicated that a seminar on machining plastics would be very helpful. Mr. Peoples will be able to recommend some very skilled machinists that we might use to provide the demonstrations. It was also suggested that a seminar be offered in composite materials. A third suggestion was that we charge a small registration fee. This fee would tend to reduce the possibility that people who had indicated their attendance and failed to appear would now feel an obligation to attend. Mr. Fink entered before the committee's consideration a seminar topic on recycling plastics.

   A suggestion was made that we try and contact those persons who are vendors or subcontractors to Boeing as a possible source for our program students.

Minutes of Composites Advisory Committee Meeting
March 29, 1989

It was suggested that we contact SAMPE for labels of their membership so that we could mail to their newsletter population.

MaryGail Hutchins, functioning as editor of the SAMPE Newsletter, Wilmington-Philadelphia Chapter, offered to provide half of the back page of the next issue for a community college composite program advertisement. She indicated that she would have to receive the information somewhere between April 14 and 21.

We were also informed that ICI would be very interested in interviewing our program graduates. Also Mr. Hung Kim would appreciate being contacted to arrange for co-op students.

Dr. McQuay approached the problem of chemical waste disposal. The committee members indicated that we should contact Snow Disposal, AETC, or Tacony to determine which one of those companies might be able to service our needs.

5. The meeting adjourned and some of the committee members joined our faculty in a tour of the composites laboratory at Marple Technical School.

DELAWARE COUNTY COMMUNITY COLLEGE
COMPOSITES AND REINFORCED PLASTICS TECHNOLOGY

First Semester	Credits
Technical Mathematics I MAT. 110- -	4
Composite Materials CMT. 100- -	3
Technical Drawing TDD. 124- -	3
Basic Technical Skills TME. 115- -	3
Introduction to Chemistry CHE. 106- -	3
	16

Second Semester	Credits
Materials Science TME. 110- -	3
Computer-Aided Drafting TDD. 225- -	3
Thermoset Composite Materials Fabrication CMT. 101- -	4
Technical Mathematics II MAT. 111- -	4
Technical Physics I PHY. 100- -	3
	17

Third Semester	Credits
Composite Drawing and Design CMT. 110- -	3
English Composition I ENG. 100- -	3
Thermoplastic Composite Materials Fabrication CMT. 102- -	4
Manufacturing Process I TME. 121- -	2
Humanities Elective- -	3
	15

Fourth Semester	Credits
English Composition II ENG. 112- -	3
Applications of Reinforced Plastics CMT. 120- -	3
Composite Materials Testing CMT. 103- -	4
Numerical Control I TME. 100- -	3
Social Science Elective- -	3
	16
Total Hours Required:	64

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CMT 100
Composite Materials

Course Objectives:

A. The student will show his understanding of current composite technology by:

   1. identifying matrix components, their properties, and their uses.

   2. selecting proper reinforcements and giving examples of different applications.

B. The student would identify and evaluate commercial reinforced uncured materials based on specifications.

C. The student will present a method of combining matrix materials and reinforcements into composite structures by listing the advantages of the assembly.

D. The student will demonstrate his awareness of the principles of safety as applied to the use of composite materials.

Course Outline:

A. Overview

   1. Background and historical development
   2. Definition of composites

B. Matrix materials

   1. Plastics
      a. Thermosetting plastics
      b. Thermoplastics

   2. Other matrix materials

C. Reinforcements

   1. Type

      a. Fiberglass
      b. Graphite
      c. Aramid
      d. Other reinforcements

2. Form

a. Fabric and tape
b. Roving and chopped fiber
c. Filaments
d. Whiskers
e. Honeycomb

D. Fillers

E. Surface finish

F. Commercial semiprocessed intermediates

1. Prepreg
2. Molding compound

a. sheet
b. bulk

3. Filament and tape

G. Applications (including structures)

H. Auxiliary considerations

1. Handling and Storage
2. Safety
3. Quality Control

I. Miscellaneous

SYLLABUS
CMT. 100
Composite Materials

1. The student will relate his understanding of matrices used in current composites by

1.1 recognizing the properties and citing examples of thermoset and thermoplastic materials.

1.2 distinguishing between the processing variables of these materials.

1.3 listing the advantages and disadvantages of each.

2. The student will be able to select the proper reinforcement by

2.1 differentiating between fiberglass, graphite and aramid reinforcements by visual examination and property definition.

2.2 recognizing different forms of reinforcement (roving, woven, nonwoven).

2.3 selecting different reinforcement materials and correctly applying them in accordance with their specific properties.

3. The student will state the uses and limitations of various fillers.

4. The student will identify and evaluate commercial semiprocessed intermediates by

4.1 identifying and applying the design constraints used in selecting prepreg, Sheet Molding Compound (SMC), and Bulk Molding Compound (BMC).

4.2 evaluating commercial semiprocessed intermediates based on specifications.

5. The student will

5.1 list and use methods of synthesizing parts and structures using reinforcements and matrix materials.

5.2 list the advantages and disadvantages of the different assemblies and techniques.

6. The student will

6.1 assess the overall handling and storage requirements necessary for the processing of composite materials.

6.2 identify reasons for and provide requirements concerning personal safety when dealing with composite materials.

COMPOSITE LAB. EQUIPMENT

TITLE

BAND SAW
WORK BENCHES
BRIDGEPORT MILLING MACHINE
FLAMMABLE LIQUID CABINET
STORAGE CABINET
CURING OVEN
DRILL PRESS
FILAMENT WINDER
FREEZER
SAFETY HOOD
HYDRAULIC PRESS
INJECTION MOLDING MACHINE
LATHE
MATERIALS RACK
SPRAY BOOTH
VACUUM PUMP
AIR COMPRESSOR
TENSILE TESTER
ULTRASONIC BONDER
ULTRASONIC TEST CENTER
GEL COAT SPRAY UNIT
CHOPPER GUN & SPRAY UNIT
IBM 360 PC AND ACCESSORIES

DCCC COMPOSITES LABORATORY

BIBLIOGRAPHY OF BOOKS IN FACILITY LIBRARY

Handbook of Composites, George Lubin (Ed). Van Nostrand Reinhold Book Co., New York, NY (1982)

Composites: A Design Guide, Terry Richardson. Industrial Press, N.Y., N.Y. (1987) (Probable textbook for CMT 100)

Fiber Reinforced Composites: Materials Manufacturing and Design, P.K. Mallick. Marcel Dekker, Inc., New York, NY (1988)

Encyclopedia of Composite Materials and Components, M. Grayson, (Ed). John Wiley and Sons, New York, NY (1983)

Composite Materials Handbook, M.M. Schwartz. McGraw-Hill Book Company, N.Y. (1984)

Engineers' Guide to Composite Materials. J.W. Weeton, D.M. Peters, K.L. Thomas (eds). ASM, Metals Park, OH (1987)

Fabrication of Composite Materials Source Book, M.M. Schwartz (Ed) ASM Metals Park, OH (1985)

Carbon Fibers: Technology, Uses and Prospects, The Plastics and Rubber Institute of London, England (Ed), Noyes Publications, Park Ridge, NJ (1986)

Composite materials, Testing and Design, Seventh Conference, J.M. Whitney (Ed). STP 893, ASTM, Philadelphia, PA (1984)

Applications of Composite Materials, M.J. Salkind and G.S. Holister (Eds). STP 524, ASTM, Philadelphia, PA (1973)

Effects of Defects in Composite Materials, ASTM Editorial Staff. STP 836, ASTM, Philadelphia, PA (1984)

Materials Analysis by Ultrasonics: Metals, Ceramics, Composites. A. Vary (Ed), Noyes Data Corporation, Park Ridge, NJ (1987)

Tough Composite Materials, Recent Developments, NASA Langley Research Center. Noyes Publications, Park Ridge, NJ (1985)

Mold Design I. E.P. Allyn, Allyn Air Publishing, Woodstock, N.Y., (1980)

Advanced Thermoset Composites. Industrial and Commercial Applications. J. M. Margolis (Ed), Van Nostrand Reinhold Co., Inc. N.Y.; N.Y. (1986)

Engineered Materials Handbook, Vol. 1 Composites ASM International Handbook Committee, ASM, Metal Parks, OH (1987)

Introduction to Composite Technology, S. Luce.

Industrial Plastics, R.J. Baird and D.T. Baird, Goodheart - Willcox Co., South Halland, IL. (1986)

Industrial Plastics: Theory and Applications, Terry L. Richardson, Delmar Publishers, Inc., Albany, N.Y. (1989)

ASTM Standards and Literature References for Composite Materials, 1st Edition, ASTM, Philadelphia, PA (1987)

Plastics Technology, R.V. Melby. McGraw Hill Book Company, N.Y. (1973)

Space Shuttle: A Triumph in Manufacturing, R.L. Vaughn (Ed) SME, Dearborn, MI (1985)

Experimental Characterization of Advanced Composite Materials, L.A. Carlsson and R.B. Pipes, Prentice-Hall, Inc. Englewood Cliffs, N.J. (1987)

Basic Physics in Diagnostic Ultrasound J.L. Rose and B.B. Goldberg. John Wiley & Sons, New York, NY (1979)

Ultrasonic Nondestructive Testing Laboratory Experiments Manual, J.L. Rose and Y.H. Jeong, Drexel University (1984)

Fundamentals of Composites Manufacturing, A. B. Strong, SME, Dearborn, MI, (1989)

Modern Plastics Encyclopedia, 1988. McGraw-Hill Publishing Co.

General Dynamics Nondestructive Testing Series of Programmed Instruction Handbooks.

PL4-1	Introduction
PL4-2	Liquid Penetrant
PL4-3	Magnetic Particle
PL4-4	Ultrasonics Vol. 1, II, & III
PL4-5	Eddy Current
PL4-6	Radiographic Testing Vol. I, II, III, IV, V.

General Dynamics Testing Series of Classroom Training Handbooks

CT6-2	Liquid Penetrant
CT6-3	Magnetic Particle
CT6-4	Ultrasonic
CT6-5	Eddy Current
CT6-6	Radiographics

VIDEOS

"Spate 9000" Ometron Corporation's
NDT Series, Infrared Imaging for Composite Flaws.

"Manufacturing Insights #7: Composites." SME,
Dearborn, MI

"Diatrim Tools"

"Large Boat Hulk Construction with the Venus
Impregnator"

"Glas-Craft ISD-II and LPA-II Tooling"

"Operation of Venus H.I.S. Choppers and Gelcoaters"

"Hydrajector in Production," Venus Products

"Introduction to Polymer Composites" Edison Polymer
Innovation, Corporation, Broadview Heights, OH.

"Gambling with Your Gel Coat"

"Low Styrene Emission" Reichhold

"Polyester Resin Cleaner" Reichhold

"Protecting our Future" Reichhold

"Plastics Recycling Today" SPI

"USD 10 Instructional" Krautkramer Branson
Ultrasonics Corp.

PERIODICALS

"Polymer Composites," Society of Plastics Engineers

"Journal of Composites Technology and Research," ASTM

"Plastic Engineering," Society of Plastics Engineers

"Plastics Technology," Bill Communications, Inc.

"Modern Plastics," McGraw Hill

"Sampe Journal," Society for the Advancement of Materials and Process Engineering.

SLIDE PRESENTATIONS

"Advanced Composite Materials and Practices"

SOFTWARE FOR IBM PC

"Polybase" DSM Polymer selection service
DSM Corp. The Netherlands

DOCUMENT: BOOKS.MAS, 6-14-88, (separate disk).

PROFESSIONAL ORGANIZATIONS

1. American Association for the Advancement of Science
2. American Chemical Society
3. Society of Plastic Engineers
4. Society for the Advancement of Materials and Process Engineering
5. Composites Groups of the Society of Manufacturing Engineers.

Delaware County Community College

Media, Pennsylvania 19063

SYMPOSIUM

Topic: **Applications of Plastics and Composites to Architecture and Construction**

Date: **Wednesday, November 30th, 1988**

Time: **9:00 A.M. to 4:30 P.M.**

Lunch: **12:00 P.M. - 1:00 P.M.**
Lunch available for purchase at the College Cafeteria

Speakers and Events:

General Electric, Pittsfield, MA.
Creative Pultrusion, Alum Banks, PA
Edon Corporation, Horsham, PA
Dow Chemical, U.S.A.; Granville, OH
Tour of DCCC facilities

Location: **DCCC Auditorium**
Room A216

Registration:

By phone. Call Mrs. Hickman at 359-5142, or send the tear portion of this mailer to:

Composites in Architecture
Delaware County Community College
Route 252 and Media Line Road
Media, Pennsylvania 19063

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REGISTRATION FORM

NAME: _____

AFFILIATION: _____

ADDRESS: _____

_____

PHONE: _____